IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:	)	Group Art Unit: 1745
RICHARD D. BREAULT, et al.	)	Examiner:
Serial No.	)	Filed:
For: DIRECT ANTIFREEZE COOLED	)	
FUEL CELL	)	Atty. Docket No. C-2269A

PRELIMINARY AMENDMENT FOR DIVISIONAL APPLICATION FILED UNDER 37 C.F.R. § 153(b)

Commissioner of Patents and
Trademarks
Washington, D.C. 20231

Commissioner:

This Preliminary Amendment accompanies a concurrently filed divisional application of its parent application, U.S. Patent Application Serial No. 09/359,475, that bears the same title, "Direct Antifreeze Cooled Fuel Cell", and that was filed on July 22, 1999 by the same inventors as the inventors of this divisional application. The 09/359,475 parent application is to issue on November 13, 2001 as U.S. Patent No. 6,316,135. During the prosecution of that parent application, amendments were made to the specification and claims to resolve concerns raised by Examiner Stephen Kalafut. Additionally, claims were canceled from the parent application for purposes of presentation in the accompanying divisional application.

Therefore, in order to eliminate the prior concerns of the Examiner, to reference this divisional application to its parent application, to conform the "Abstract of the Disclosure" to contemporary requirements of being no longer than 150 words, and to present claims for consideration, please amend the accompanying divisional application as follows:

IN THE SPECIFICATION:

At Page 1, line 3, after the Title "Direct Antifreeze Cooled Fuel Cell", please add the following caption and new paragraph:

-- Cross Reference to Related Applications

This is a divisional application of pending U.S. Patent Application Serial No. 09/359,475, that was filed on July 22, 1999, that has the same title, and that is to issue on November 13, 2001 as U.S. Patent No. 6,316,135. --

Please replace the paragraph beginning at page 12, line 15, with the following rewritten paragraph:

-- The fuel cell 10 also includes a wetproofed cathode support means that is secured in direct fluid communication with the cathode catalyst 56 between a cathode water transport plate 64 and the cathode catalyst 56 for passing the process oxidant stream adjacent the cathode catalyst 56. The wetproofed cathode support means may include one or more porous layers, such as a porous cathode substrate 62, a porous cathode diffusion layer 68, or both the porous cathode substrate 62 and porous cathode diffusion layer 68 secured adjacent each other between the cathode water transport plate 64 and cathode catalyst 56, wherein at least one of the porous layers is wetproofed. The porous cathode substrate 62 and porous anode substrate 58 may be porous carbon-carbon fibrous composites having a porosity of about 65% to about 75%, and may be wetproofed by a hydrophobic substance such as "TEFLON" brand polytetrafluoroethylene (as described in more detail below) to a concentration of approximately 0.18 grams per cubic centimeter. The porous cathode gas diffusion layer 68 and porous anode diffusion layer 66 may be about a 50% carbon material and about 50% hydrophobic material such as "TEFLON" brand polytetrafluoroethylene (as described in more detail below). --

Please replace the paragraph beginning at page 16, line 6, with the following rewritten paragraph:

-- The porous anode and cathode substrate layers were porous carbon - carbon fibrous composite having a thickness of approximately 0.006 - 0.007 inches, and a porosity of about 65 - 75 percent, and were acquired as grade TGP-H-060 from the Toray Company of New York, NY. The anode and cathode substrate layers were uniformly wetproofed with "TEFLON" brand polytetrafluoroethylene, grade "FEP - 121" sold by the E.I. DuPont Company, of Willmington, DE, to a concentration of approximately 0.18 grams per cubic centimeter by wetproofing procedures well-known in the art. --

Please replace the paragraph beginning at page 16, line 16, with the following rewritten paragraph:

-- The porous anode and cathode gas diffusion layers were applied to both the anode and cathode substrates by procedures well-known in the art and described in U.S. Patent 4,233,181, which patent is owned by the assignee of all rights in the present invention, and which patent is hereby incorporated herein by reference. The anode and cathode diffusion layers were approximately 0.003 - 0.004 inches thick, and had a mass of approximately 5.4 milligrams per square centimeter. The anode and cathode gas diffusion layers consisted of about 50 percent Vulcan XC-72 obtained from the Cabot Corporation of Billerica, MA and about 50 percent "TEFLON" brand polytetrafluoroethylene, grade "TFE - 30", obtained from the aforesaid E. I. DuPont Company. The anode and cathode gas diffusion layers were heated to approximately 660^{0}F for about 5 minutes to make them wetproofed or hydrophobic. --

Please replace the paragraph beginning at page 18, line 18, with the following rewritten paragraph:

-- The coolant stream used for the test ranged from pure water to 65% glycerol and 35% water. The glycerol used was a certified ACS grade 99.9% glycerol. It is pointed out that use herein of the word "glycerol" as a form of antifreeze solution cooling fluid is meant to include "glycerine", where "glycerine" is understood herein and in general acceptance to include glycerol and water solutions or mixtures. Concentration of the glycerol in the antifreeze solution (glycerol and water. e.g., "glycerine") was measured by determining the specific gravity of the glycerol and water solution at 20^{0}C. The antifreeze solution coolant stream was circulated through coolant flow channels in both an anode and a cathode water transport plate that defined anode and cathode flow field channels at a total flow rate of approximately 15 pounds per hour. The inlet and exit temperatures of the coolant stream entering and leaving the cell were 65^{0}C plus or minus 5^{0}C. --

Please replace the paragraph beginning at page 33, line 1 (the "Abstract of the Disclosure"), with the following rewritten paragraph:

-- A direct antifreeze cooled fuel cell is disclosed for producing electrical energy from reducing and process oxidant fluid streams that includes an electrolyte secured between an anode catalyst and a cathode catalyst; a porous anode substrate secured in direct fluid communication with and supporting the anode catalyst; a porous wetproofed cathode substrate secured in direct fluid communication with and supporting the cathode catalyst; a porous water transport or cooler plate secured in direct fluid communication with the porous cathode substrate; and, a direct antifreeze solution passing through the porous water transport plate. A preferred direct antifreeze solution passing through the porous water transport plate remains essentially within the water transport plate and does not poison the catalysts. --

IN THE CLAIMS:

Please cancel claims 2, 3, 10, 11, 16, 17, 18, 19 and 20.

Please amend claims 1, 4, 9 and 12 as follows:

1. (Amended) A direct antifreeze cooled fuel cell for producing electrical energy from a reducing fluid and a process oxidant stream, comprising:

a. an electrolyte secured between an anode catalyst and a cathode catalyst;

b. a porous anode substrate secured in direct fluid communication with the anode catalyst for passing the reducing fluid stream adjacent the anode catalyst and a wetproofed cathode support means secured in direct fluid communication with the cathode catalyst for passing the process oxidant stream adjacent the cathode catalyst;

c. a porous cooler plate secured in direct fluid communication with the wetproofed cathode support means; and,

d. a direct antifreeze solution passing through the porous cooler plate for cooling the fuel cell, wherein the direct antifreeze solution is a special direct antifreeze solution having;

i. a freezing point of at least -20^0F;

ii. a surface tension greater than 60 dyne/cm at an operating temperature of the fuel cell;

iii. a partial pressure of antifreeze above the solution at the cell operating temperature that is less than 0.005 mm Hg; and,

iv. a capacity of being oxidized by the anode and cathode catalysts at fuel cell voltages.

4. (Amended) The direct antifreeze cooled fuel cell of Claim 1, wherein the fuel cell includes a pressure control means for maintaining a positive pressure differential between the process oxidant stream passing through the fuel cell and the antifreeze solution passing through the porous cooler plate so that the process oxidant stream within the fuel cell is at a greater pressure than the antifreeze solution within the cooler plate.

9. (Amended) A direct antifreeze cooled fuel cell for producing electrical energy from a reducing fluid and a process oxidant stream, comprising:

a. an electrolyte secured between an anode catalyst and a cathode catalyst;

b. a wetproofed anode support means secured in direct fluid communication with the anode catalyst for passing the reducing fluid stream adjacent the anode catalyst and a wetproofed cathode support means secured in direct fluid communication with the cathode catalyst for passing the process oxidant stream adjacent the cathode catalyst;

c. a porous anode cooler plate secured in direct fluid communication with the wetproofed anode substrate means; and a porous cathode cooler plate secured in direct fluid communication with the wetproofed cathode support means; and,

d. a direct antifreeze solution passing through the porous anode and cathode cooler plates for cooling the fuel cell, wherein the antifreeze solution is a special direct antifreeze solution having;

   i. a freezing point of at least -20^{0}F;

   ii. a surface tension greater than 60

dyne/cm at an operating temperature of the fuel cell;

iii. a partial pressure of antifreeze above the solution at the cell operating temperature that is less than 0.005 mm Hg; and,

iv. a capacity of being oxidized by the anode and cathode catalysts at fuel cell voltages.

12. (Amended) The direct antifreeze cooled fuel cell of Claim 9, wherein the fuel cell includes a pressure control means for maintaining a positive pressure differential between the process oxidant stream passing through the fuel cell and the antifreeze solution passing through the porous anode and cathode cooler plates so that the process oxidant stream within the fuel cell is at a greater pressure than the antifreeze solution within the cooler plates.

REMARKS

I. SUMMARY OF PROSECUTION OF PARENT APPLICATION

The parent application, U.S. Patent Application Serial No. 09/359,475 claimed in essence a fuel cell having a "direct antifreeze solution" passing through a porous water transport or cooler plate that is secured in "direct fluid communication" with a "wetproofed cathode support means", which in turn is also "secured in direct fluid communication with the cathode catalyst". (See Claim 1.) The inventors found that a "direct antifreeze solution" could pass through the porous cooler plate without limiting performance of the fuel cell by contacting to an excessive degree the cathode catalyst or anode catalyst. By

utilizing a porous cooler plate in fluid contact with the cathode catalyst, product water generated at the catalyst could flow into the cooler plate, so that the cooler plate would not have to be sealed from the reactant streams flowing through the fuel cell. (See Specification, at page 23, lines 15 - 20.)

Three specific types of the direct antifreeze solution were described. An "organic antifreeze solution that does not wet the wetproofed cathode support means and that is non-volatile at cell operating temperatures" is one description of the "direct antifreeze solution". (See Claim 1 prior to amendment.) An "alkanetriol direct antifreeze solution" is a second description of the "direct antifreeze solution". (See Claim 2.) And, a third description of the "direct antifreeze solution" is a "special direct antifreeze solution having; i. a freezing point of at least -20^{0}F; ii. a surface tension greater than 60 dyne/cm at an operating temperature of the fuel cell; iii. a partial pressure of antifreeze above the solution at the cell operating temperature that is less than 0.005 mm Hg; and, iv. a capacity of being oxidized by the anode and cathode catalysts at fuel cell voltages". (See amended Claims 1 and 9 in this divisional application.)

During prosecution of the parent application, the first and third descriptions were canceled, and the Examiner allowed claims including the "alkanetriol direct antifreeze solution". In addition, during prosecution, the Examiner rejected all of the pending claims under 35 U.S.C. § 112, second paragraph with respect to usage of the phrase "water transport plate", and Applicants amended the claims to include the phrase "cooler plate" instead, and recited in their response the antecedent bases therefor. The Examiner also objected to the parent specification for a misspelling of the word "glycerine", and for usage of the trademark "TEFLON" without being accompanied by generic terminology. By this Preliminary Amendment, the

amendments made in the parent application are brought forth into this divisional application to resolve those concerns of the Examiner.

The undersigned hereby incorporates herein by reference to amendments made to the parent the same amendments made above to resolve the Examiner's concerns. In the parent application, those amendments were entered, and have become part of the patent to issue from the parent on November 13, 2001 as U.S. Patent No. 6,316,135. The above amendments to the specification of this divisional application also introduce a reference to the parent after the title, and also reduce the length of the "Abstract of the Disclosure" to be no greater than 150 words.

II. CLAIMS OF THIS DIVISIONAL APPLICATION

By this divisional application, the Applicants have accepted the position of the Examiner with respect to the first description of the "direct antifreeze solution" as an "organic antifreeze solution" having the properties described in unamended Claim 1. However, the Applicants urge that the specific properties of the third description of the direct antifreeze solution identified above and referred to as a "special direct antifreeze solution" are patentable. Therefore, claim 1 has been amended by this Preliminary Amendment to include those "special direct antifreeze solution" properties.

In the October 10, 2000 First Office Action on the parent application, the Examiner rejected the properties of the "special direct antifreeze solution" then found in Claim 9 under 35 U.S.C. § 112 first paragraph "because the specification, while being enabling for the recited antifreeze compounds, the class of alkanetriols, does not reasonably provide enablement for any and all organic compounds. The specification does not enable any person skilled in the art to which it pertains, or with which it

is most nearly connected, to make and use the invention commensurate in scope with these claims. These claims recite the compounds only according to their properties, which would create a trial-and-error situation when one attempts to practice the invention. The claims also encompass compounds that are never recited in the specification, but could later be shown by others to exhibit the same properties." (First Office Action on parent application, Section 2.)

Applicants will establish that the fuel cell recited in claim 1 as amended can be made and used by one skilled in the art without undue experimentation, and that amended claims 1 and 9 are thoroughly supported in the disclosure.

> "The determination of the propriety of a rejection based upon the scope of a claim relative to the scope of the enablement involves two stages of inquiry. The first is to determine how broad the claim is with respect to the disclosure. The entire claim must be considered. The second inquiry is to determine if one skilled in the art is enabled to make and use the entire scope of the claimed invention without undue experimentation."

M.P.E.P., at § 2164.08

Because of unforeseen time constraints, Applicants are unable to present their full argument at the time of necessary filing of this divisional application and this Preliminary Amendment. This divisional application must be filed no later than November 13, 2001 to preserve copendency with the parent application. (See M.P.E.P. § 201.11.) Within a few weeks after filing of this divisional application, Applicants will file a "Second Preliminary Amendment" which will include an Affidavit of an inventor, who is one skilled in the art, to establish that the fuel cell disclosed in Claim 1 (as amended herein) could be

made and used without undue experimentation. Additionally, that "Second Preliminary Amendment" will set forth Applicants' position that the specification is properly enabling for the amended claims of this divisional application.

Applicants extend in advance their appreciation to Examiner Kalafut or to the Examiner responsible for this divisional application for any inconvenience caused by the necessity of filing this divisional application and Preliminary Amendment prior to the completion and filing of the affidavit of one skilled in the art and a "Second Preliminary Amendment".

Attached hereto is a marked-up version of the changes made by the current amendment to the specification and claims 1, 4, 9, and 12. The method of marking up in the attached marked-up version is that material deleted by this Amendment is shown in brackets, and material added by this Amendment is shown with underlining. The attached marked-up version is entitled **"Version With Markings to Show Changes Made."**

Respectfully submitted,
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Date: 11/29/01

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Version With Markings to Show Changes Made

IN THE SPECIFICATION:

The paragraph beginning at page 12, line 15, has been amended as follows:

The fuel cell 10 also includes a wetproofed cathode support means that is secured in direct fluid communication with the cathode catalyst 56 between a cathode water transport plate 64 and the cathode catalyst 56 for passing the process oxidant stream adjacent the cathode catalyst 56. The wetproofed cathode support means may include one or more porous layers, such as a porous cathode substrate 62, a porous cathode diffusion layer 68, or both the porous cathode substrate 62 and porous cathode diffusion layer 68 secured adjacent each other between the cathode water transport plate 64 and cathode catalyst 56, wherein at least one of the porous layers is wetproofed. The porous cathode substrate 62 and porous anode substrate 58 may be porous

carbon-carbon fibrous composites having a porosity of about 65% to about 75%, and may be wetproofed by a hydrophobic substance such as ["Teflon"] "TEFLON" brand polytetrafluoroethylene (as described in more detail below) to a concentration of approximately 0.18 grams per cubic centimeter. The porous cathode gas diffusion layer 68 and porous anode diffusion layer 66 may be about a 50% carbon material and about 50% hydrophobic material such as [Teflon] "TEFLON" brand polytetrafluoroethylene (as described in more detail below).

The paragraph beginning at page 16, line 6, has been amended as follows:

The porous anode and cathode substrate layers were porous carbon - carbon fibrous composite having a thickness of approximately 0.006 - 0.007 inches, and a porosity of about 65 - 75 percent, and were acquired as grade TGP-H-060 from the Toray Company of New York, NY. The anode and cathode substrate layers were uniformly wetproofed with [Teflon] "TEFLON" brand polytetrafluoroethylene, grade "FEP - 121" sold by the E.I. DuPont Company, of Willmington, DE, to a concentration of approximately 0.18 grams per cubic centimeter by wetproofing procedures well-known in the art.

The paragraph beginning at page 16, line 16, has been amended as follows:

The porous anode and cathode gas diffusion layers were applied to both the anode and cathode substrates by procedures well-known in the art and described in U.S. Patent 4,233,181, which patent is owned by the assignee of all rights in the present invention, and which patent is hereby incorporated herein by reference. The anode and cathode diffusion layers were approximately 0.003 - 0.004 inches thick, and had a mass of approximately 5.4 milligrams per square centimeter. The anode

and cathode gas diffusion layers consisted of about 50 percent Vulcan XC-72 obtained from the Cabot Corporation of Billerica, MA and about 50 percent [Teflon] "TEFLON" brand polytetrafluoroethylene, grade "TFE - 30", obtained from the aforesaid E. I. DuPont Company. The anode and cathode gas diffusion layers were heated to approximately 660^{0}F for about 5 minutes to make them wetproofed or hydrophobic.

The paragraph beginning at page 18, line 18, has been amended as follows:

The coolant stream used for the test ranged from pure water to 65% glycerol and 35% water. The glycerol used was a certified ACS grade 99.9% glycerol. It is pointed out that use herein of the word "glycerol" as a form of antifreeze solution cooling fluid is meant to include "glycerine", where ["glycerine"] "glycerine" is understood herein and in general acceptance to include glycerol and water solutions or mixtures. Concentration of the glycerol in the antifreeze solution (glycerol and water. e.g., "glycerine") was measured by determining the specific gravity of the glycerol and water solution at 20^{0}C. The antifreeze solution coolant stream was circulated through coolant flow channels in both an anode and a cathode water transport plate that defined anode and cathode flow field channels at a total flow rate of approximately 15 pounds per hour. The inlet and exit temperatures of the coolant stream entering and leaving the cell were 65^{0}C plus or minus 5^{0}C

The paragraph beginning at page 33, line 1, has been amended as follows:

A direct antifreeze cooled fuel cell is disclosed for producing electrical energy from reducing and process oxidant fluid streams that includes an electrolyte secured between an anode catalyst and a cathode catalyst; a porous anode substrate

secured in direct fluid communication with and supporting the anode catalyst; a porous wetproofed cathode substrate secured in direct fluid communication with and supporting the cathode catalyst; a porous water transport or cooler plate secured in direct fluid communication with the porous cathode substrate; and, a direct antifreeze solution passing through the porous water transport plate. [In operation of the fuel cell, because product water generated electrochemically at the cathode catalyst flows away from the cathode catalyst into the porous cathode substrate and into the porous water transport plate and because the porous cathode substrate is wetproofed,] A preferred direct antifreeze solution [the antifreeze solution passing through the porous water transport plate] remains essentially within the water transport plate and does not poison the catalysts. [A preferred direct antifreeze solution is glycerol. In a preferred embodiment, the direct antifreeze solution passing through the water transport plate may be directed to flow at a pressure that is less than a pressure of the process oxidant stream passing adjacent the cathode substrate and water transport plate to further minimize movement of the antifreeze solution from the water transport plate to the cathode catalyst.]

IN THE CLAIMS:

Claims 1, 4, 9 and 12 have been amended as follows:

1. (Amended) A direct antifreeze cooled fuel cell for producing electrical energy from a reducing fluid and a process oxidant stream, comprising:

a. an electrolyte secured between an anode catalyst and a cathode catalyst;

b. a porous anode substrate secured in direct fluid communication with the anode catalyst for passing the reducing fluid stream adjacent the anode catalyst and a wetproofed cathode support means

secured in direct fluid communication with the cathode catalyst for passing the process oxidant stream adjacent the cathode catalyst;

c. a porous cooler plate secured in direct fluid communication with the wetproofed cathode support means; and,

d. a direct antifreeze solution passing through the porous cooler plate for cooling the fuel cell, wherein the direct antifreeze solution is [an organic antifreeze solution that does not wet the wetproofed cathode support means and that is non-volatile at cell operating temperatures] <u>a special direct antifreeze solution having;</u>

   <u>i.</u> <u>a freezing point of at least -20^{0}F;</u>

   <u>ii.</u> <u>a surface tension greater than 60 dyne/cm at an operating temperature of the fuel cell;</u>

   <u>iii.</u> <u>a partial pressure of antifreeze above the solution at the cell operating temperature that is less than 0.005 mm Hg; and,</u>

   <u>iv.</u> <u>a capacity of being oxidized by the anode and cathode catalysts at fuel cell voltages</u>.

4. (Amended) The direct antifreeze cooled fuel cell of Claim 1, wherein the fuel cell includes a pressure control means for maintaining a positive pressure differential between the process oxidant stream passing through the fuel cell and the antifreeze solution passing through the porous [water transport] <u>cooler</u> plate so that the process oxidant stream within the fuel cell is at a greater pressure than the antifreeze solution within the [water transport] <u>cooler</u> plate.

9. (Amended) A direct antifreeze cooled fuel cell for producing electrical energy from a reducing fluid and a process oxidant stream, comprising:

a. an electrolyte secured between an anode catalyst and a cathode catalyst;

b. a wetproofed anode support means secured in direct fluid communication with the anode catalyst for passing the reducing fluid stream adjacent the anode catalyst and a wetproofed cathode support means secured in direct fluid communication with the cathode catalyst for passing the process oxidant stream adjacent the cathode catalyst;

c. a porous anode [water transport] cooler plate secured in direct fluid communication with the wetproofed anode substrate means, and a porous cathode [water transport] cooler plate secured in direct fluid communication with the wetproofed cathode support means; and,

d. a direct antifreeze solution passing through the porous anode and cathode [water transport] cooler plates for cooling the fuel cell, wherein the antifreeze solution is a special direct antifreeze solution having;

    i. a freezing point of at least -20°F;

    ii. a surface tension greater than 60 dyne/cm at an operating temperature of the fuel cell;

    iii. a partial pressure of antifreeze above the solution at the cell operating temperature that is less than 0.005 mm Hg; and,

    iv. a capacity of being oxidized by the anode and cathode catalysts at fuel cell voltages.

12. (Amended) The direct antifreeze cooled fuel cell of Claim 9, wherein the fuel cell includes a pressure control means for maintaining a positive pressure differential between the process oxidant stream passing through the fuel cell and the antifreeze solution passing through the porous anode and cathode [water transport] <u>cooler</u> plates so that the process oxidant stream within the fuel cell is at a greater pressure than the antifreeze solution within the [water transport] <u>cooler</u> plates.

Respectfully submitted,
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